Program 8 Investigation of the Effect of Thermal Exposure on the Mechanical Properties of Titanium/SiC Composites

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Objective

The objective of this study is to investigate the effect of thermal exposure (isothermal and thermal cycling) on the longitudinal and transverse tensile properties of Ti 1100/SCS-6 composites. The property degradation will be correlated to microstructural changes in the matrix, fibers and interface.

ABSTRACT

The objective of the present study is to evaluate the influence of thermal exposure, both isothermal and cyclic, on the reaction kinetics, mechanical properties and fracture behavior of Ti-1100 alloy/SiC fiber composites.

During the last reporting period, it was determined that composites made with TiB_2 coated SiC fiber (Sigma) reacted at the same rate as SCS-6 fibers. As a result, the thinner surface coating on the Sigma fiber was completely consumed at shorter times than that on the SCS-6.

Thermal cycling experiments were conducted on longitudinal and transverse Ti-1100/SCS-6 composites over a temperature range of 150-800°C for 500 cycles. The thermal exposures were carried out in air and in argon. No appreciable tensile strength degradation was observed for samples cycled in argon, although a strength loss was noted for the samples cycled in air. Fracture surface characterization showed brittle matrix failure in regions near the surface and in regions where there was a path for oxygen ingress.

INVESTIGATION OF THE EFFECT OF THERMAL EXPOSURE ON THE MECHANICAL PROPERTIES OF Ti-1100/SCS-6 COMPOSITES

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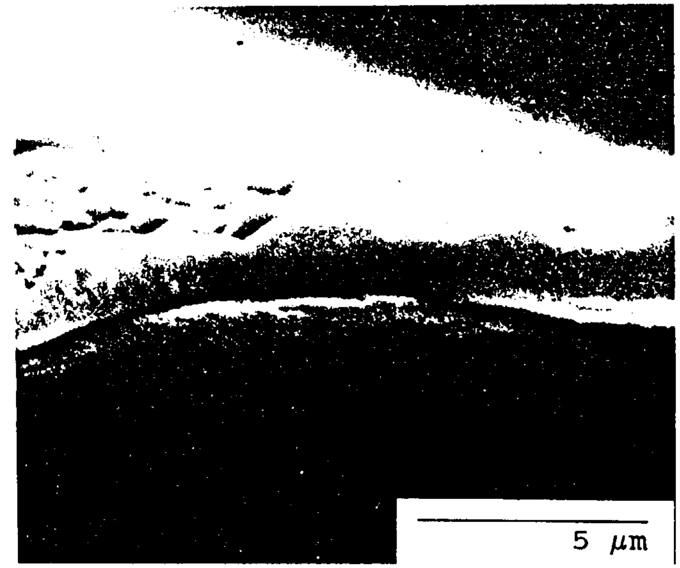
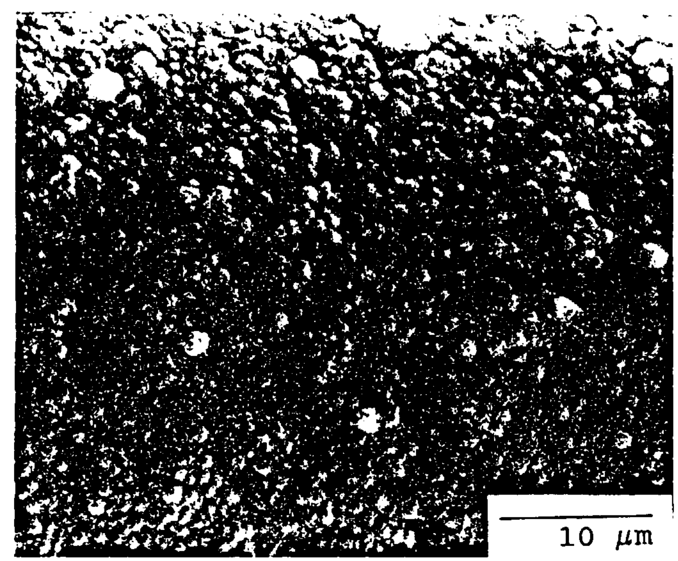
RESEARCH OBJECTIVE

The objective of this research is to investigate the influence of thermal exposure, both isothermal and cyclic, on the microstructure and mechanical properties of Ti-1100/SiC composites.

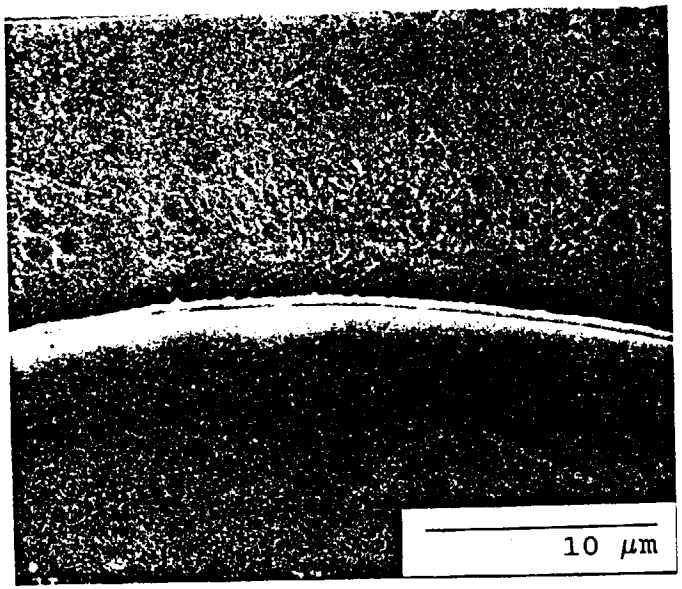
TiB_2 COATED SIGMA FIBER



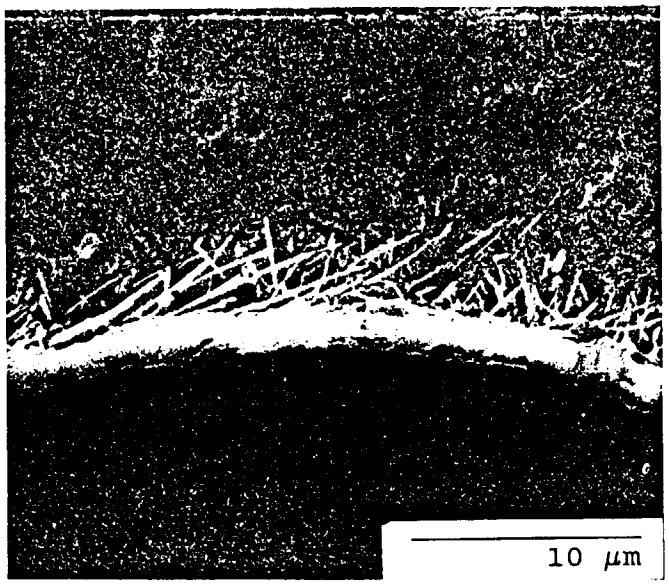


SCS-6 AND SIGMA IN Ti-1100

AS-FABRICATED

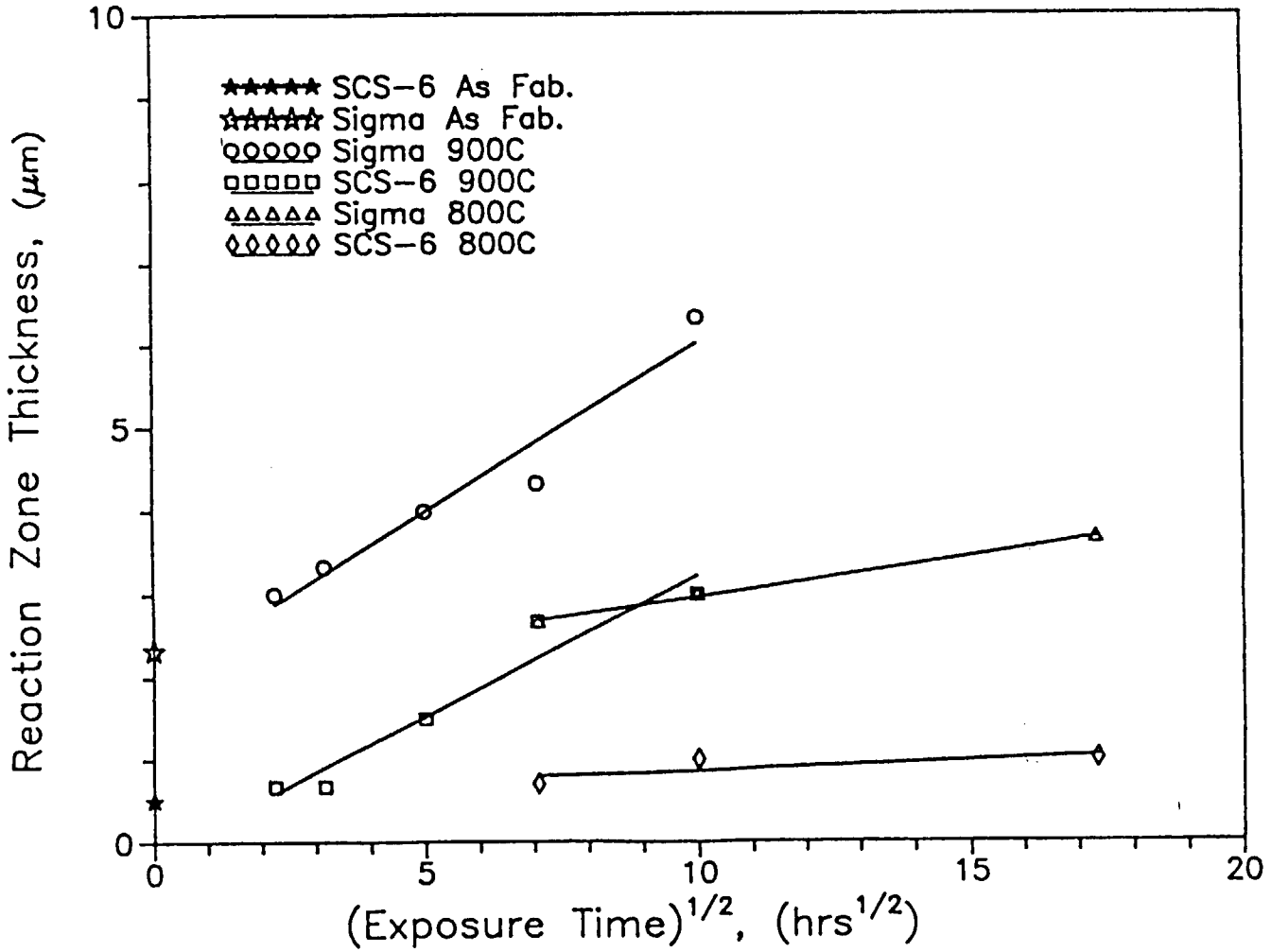


SCS-6



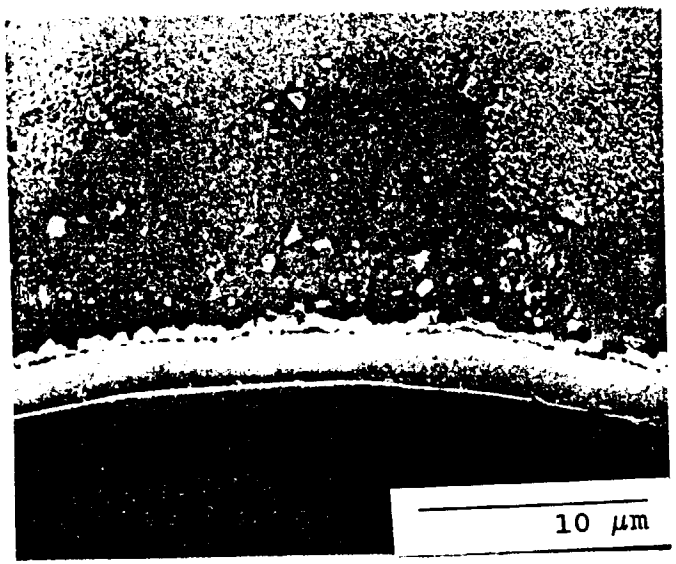
SIGMA

REACTION RATES OF SCS-6 AND SIGMA IN TI-1100 AT 800 AND 900C

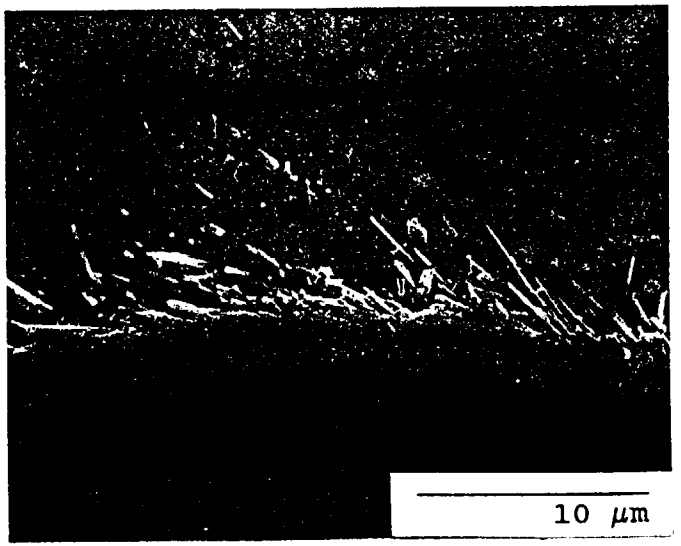


SCS-6 AND SIGMA IN Ti-1100

REACTED AT 900C FOR 50 HOURS

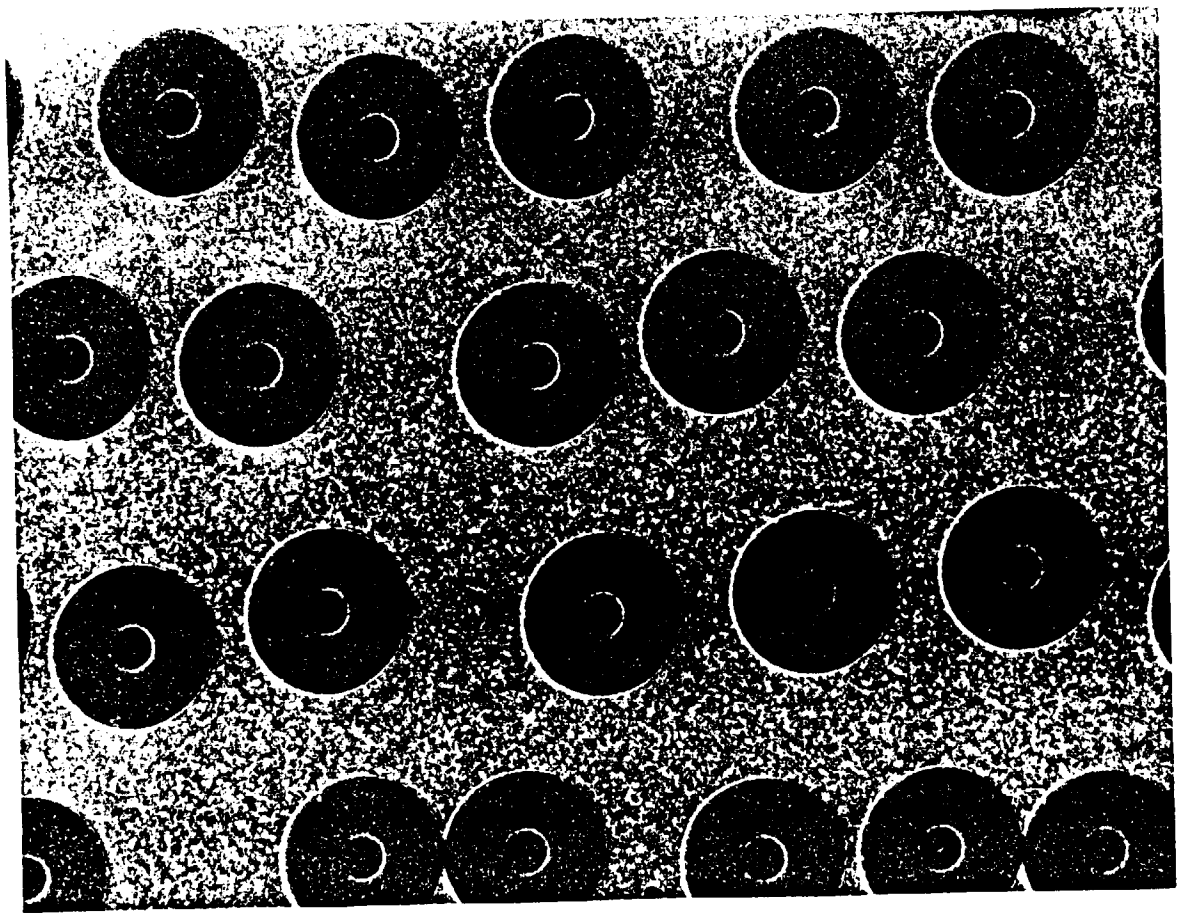


SCS-6

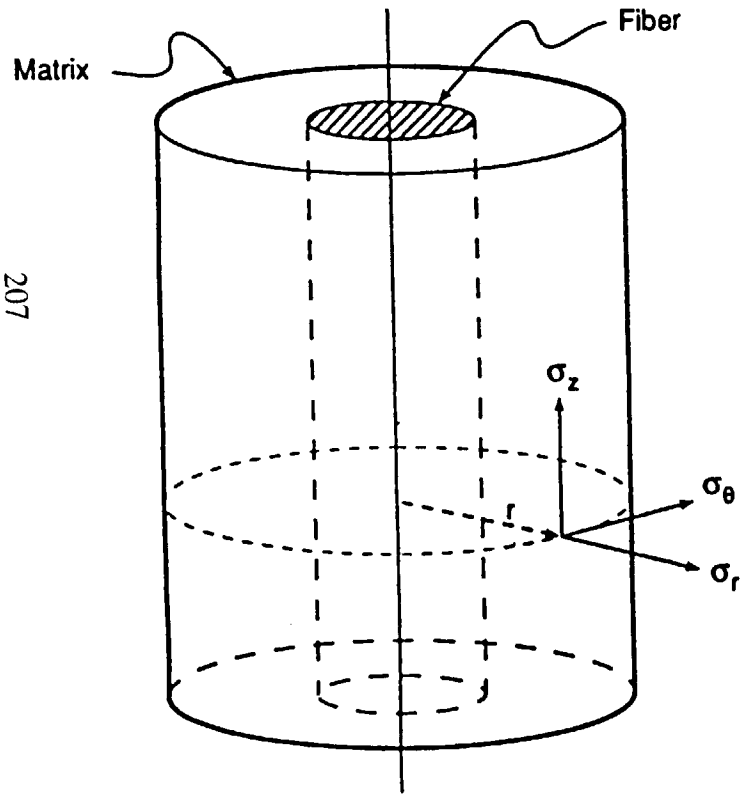


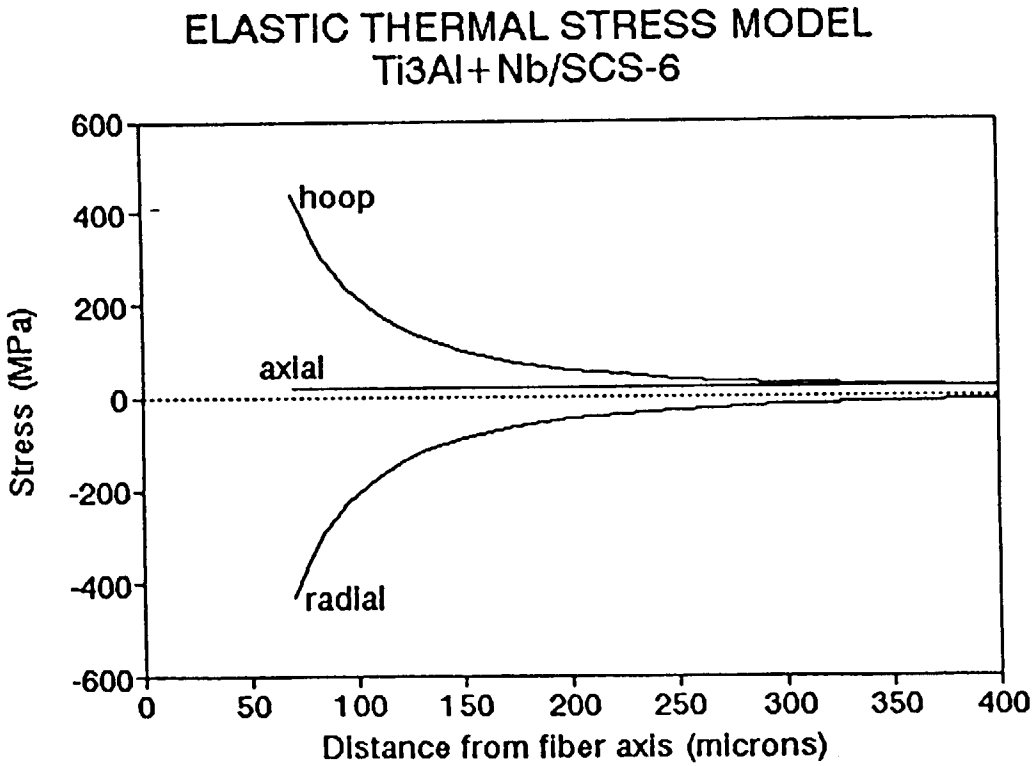
SIGMA

Ti-1100/SCS-6 COMPOSITE

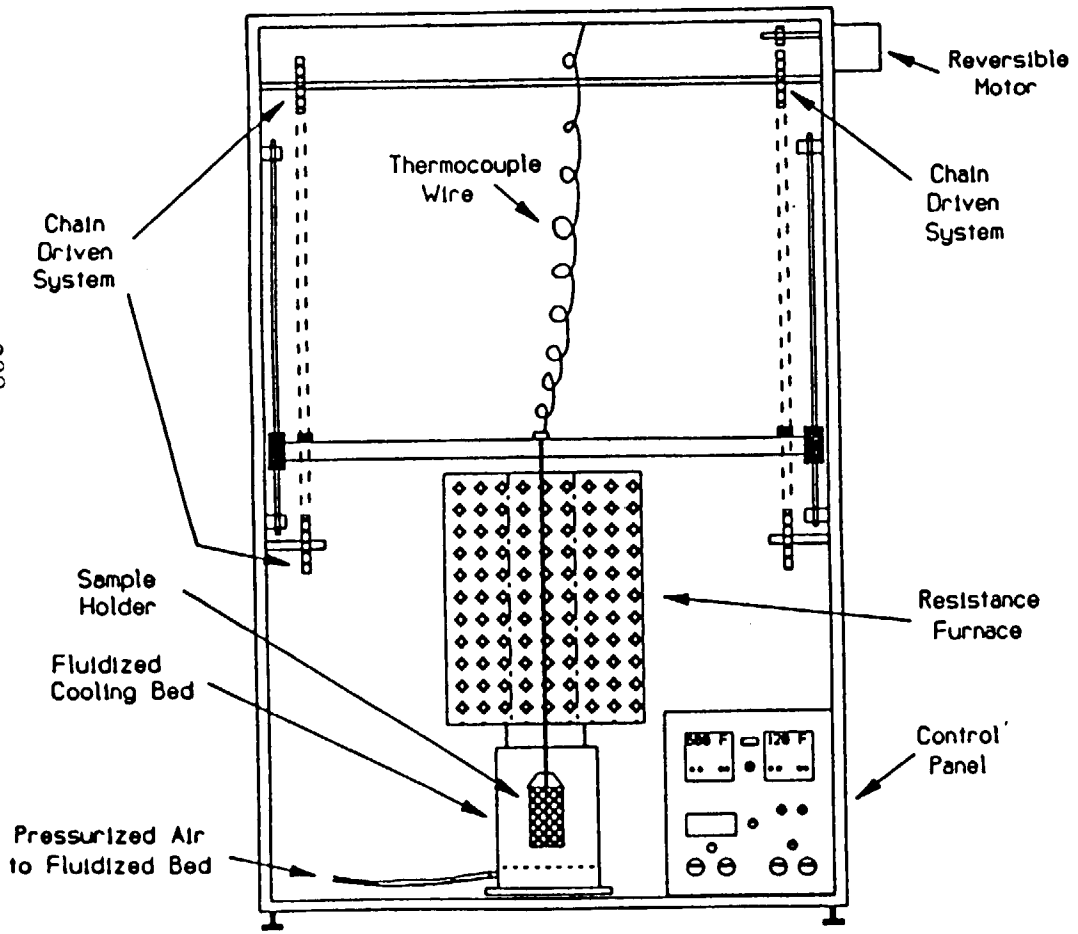


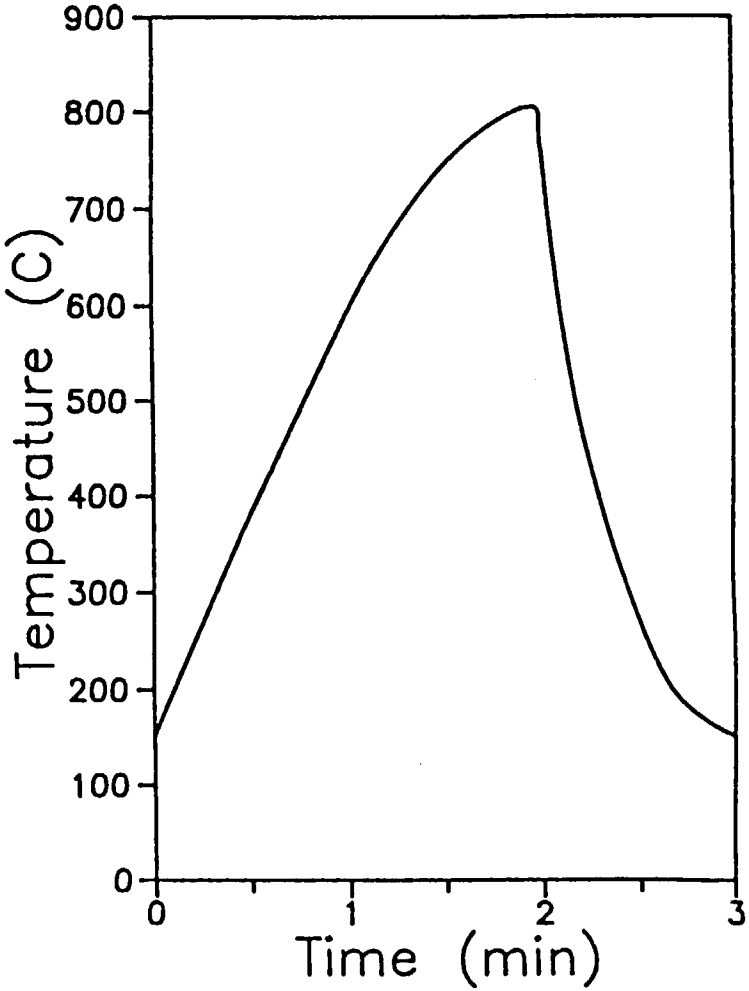
RESIDUAL THERMAL STRESSES





THERMAL CYCLING APPARATUS

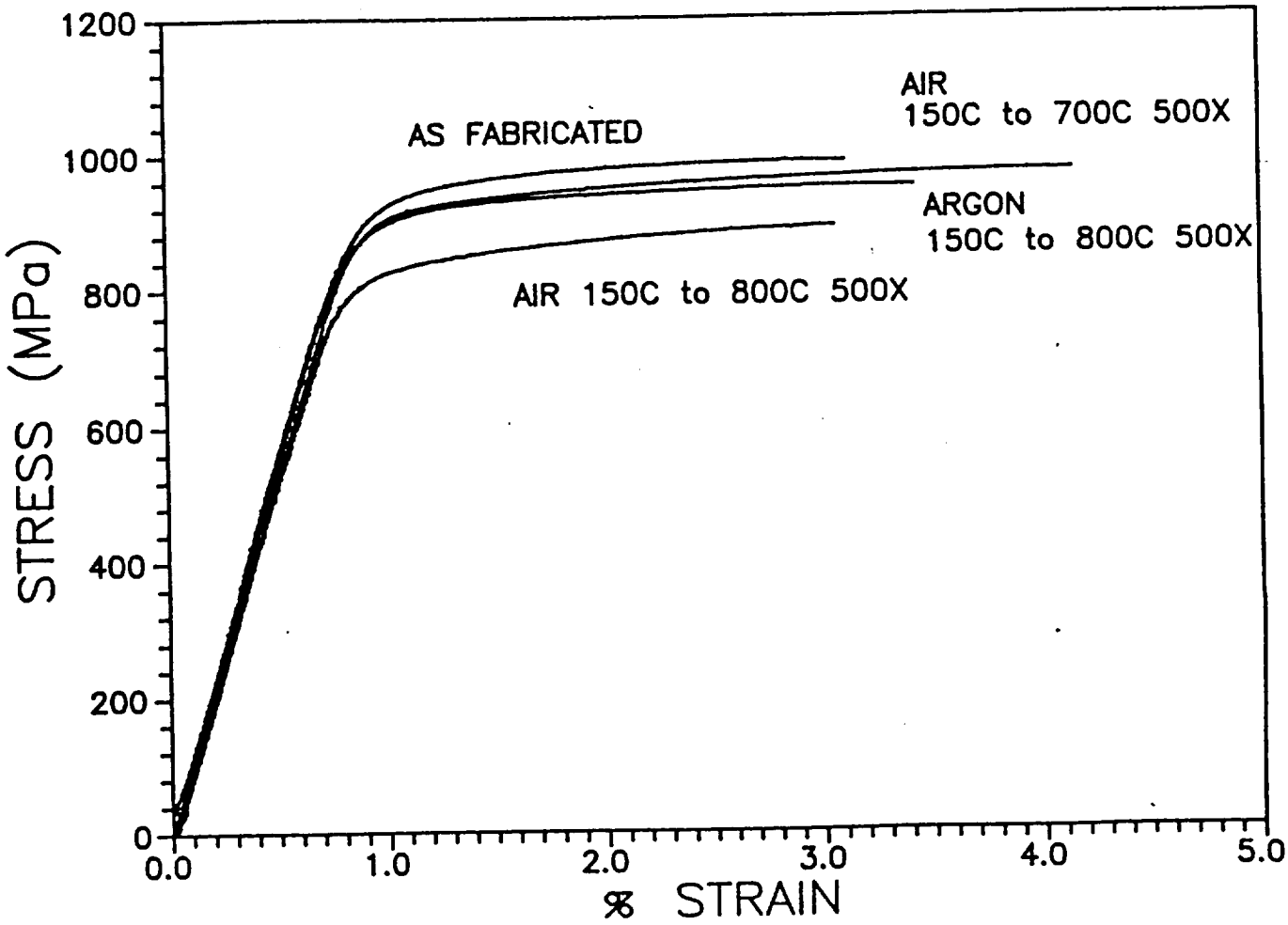




THERMAL EXPOSURES

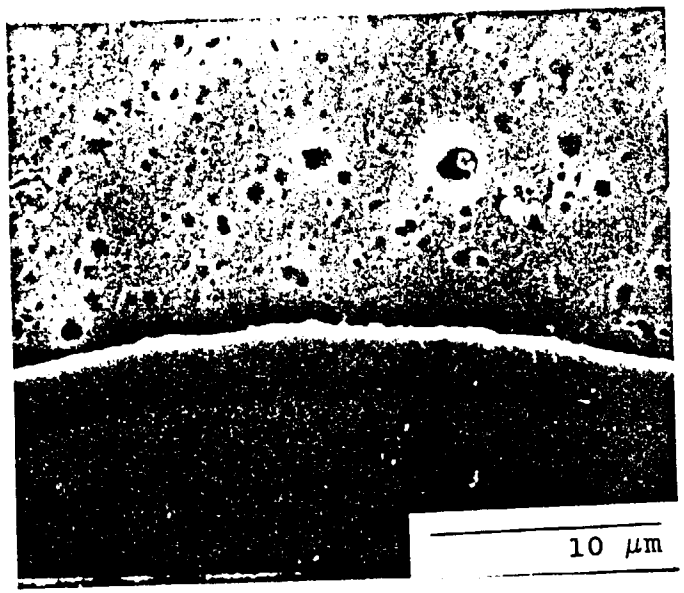
- Panels fabricated at NASA LaRC
- Tensile coupons cut prior to exposure:
  Longitudinal, Transverse, Matrix alone
- Thermal exposures:
  Cycled in air 150 to 700C 500X
  Cycled in air 150 to 800C 500X
  Cycled in argon 150 to 800C 500X
- Samples tensile tested (2 per condition)

MATRIX TENSILE TESTS

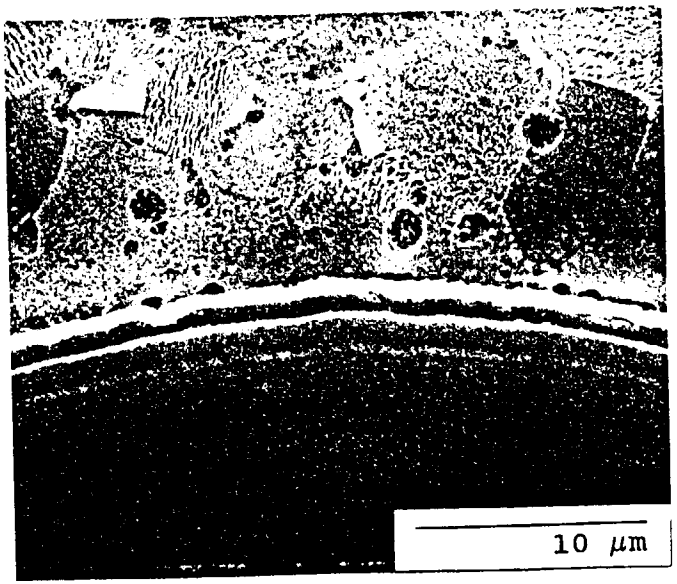


	AS FAB	150-700C 500X AIR	150-800C 500X AIR	150-800C 500X ARGON
MODULUS (GPa)	112	107	103	113
UTS (MPa)	1023	1038	910	982

Ti-1100/SCS-6 INTERFACE



As-Fabricated

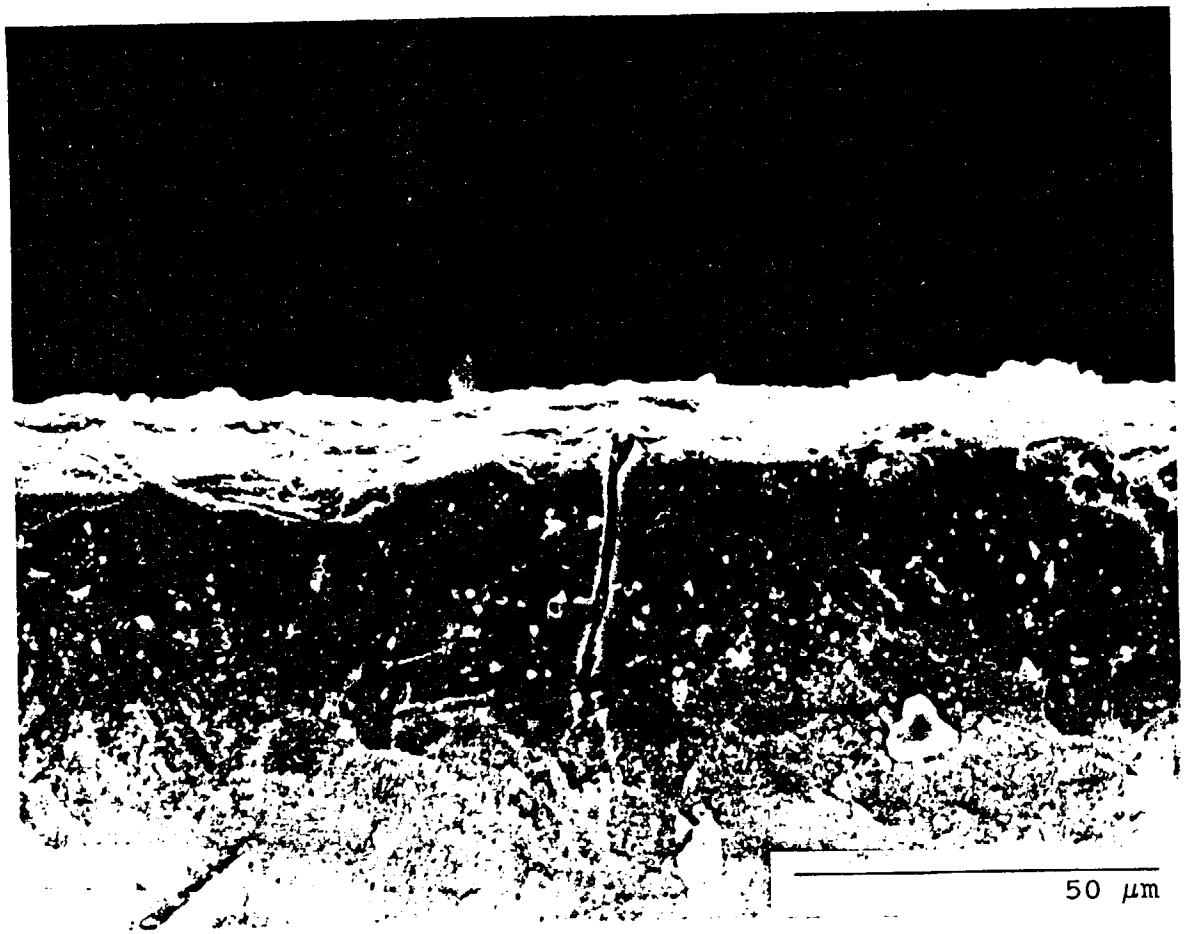


150-800C 500X Air

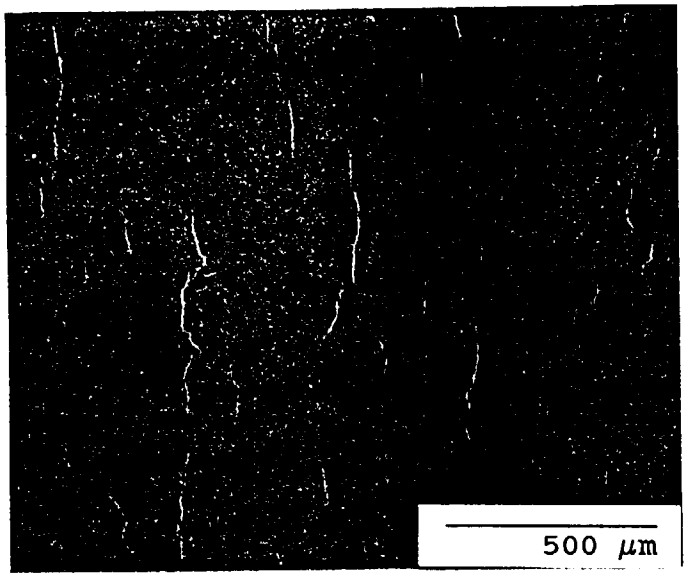
TRANSVERSE SURFACE CRACK

Tested Longitudinal Sample

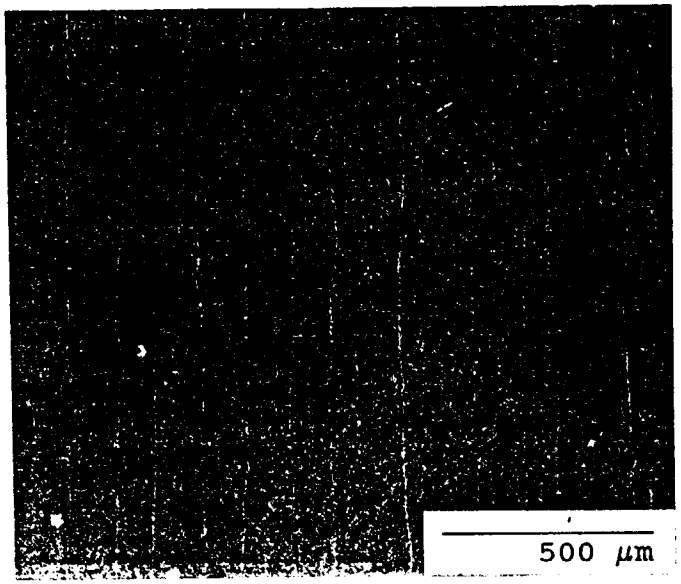
Cycled in Air 500X 150-800C



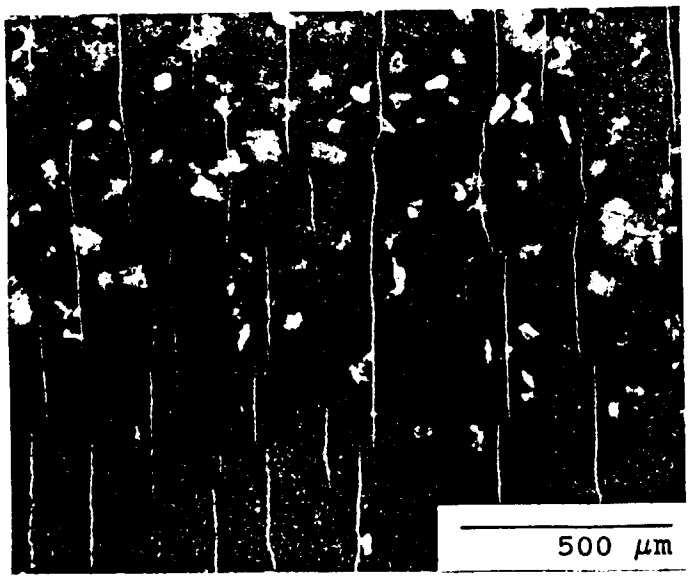
SURFACE CRACKING
(0.8% TENSILE STRAIN)



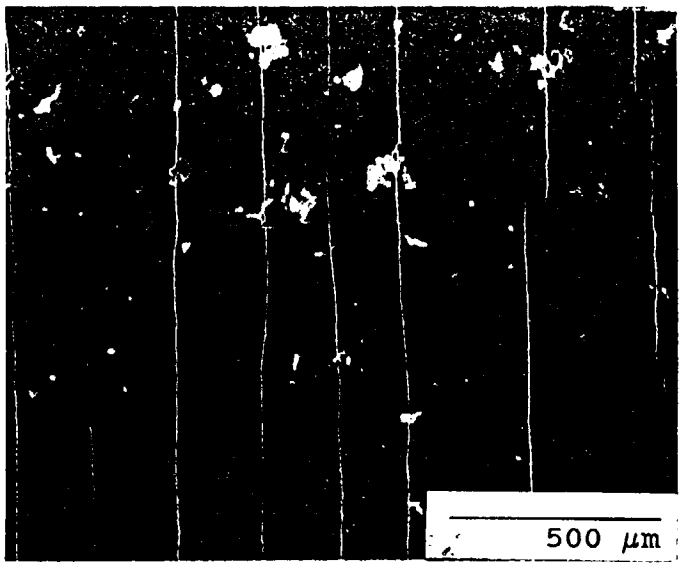
Composite
As-Fabricated



Composite
Air 150-700C 500X



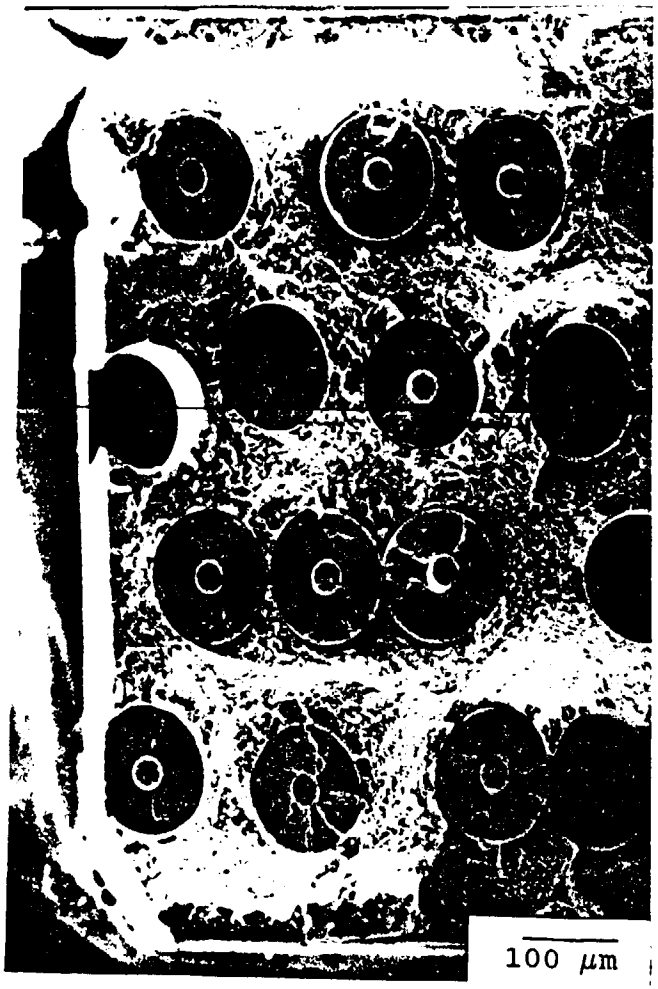
Composite
Air 150-800C 500X



Matrix
Air 150-800C 500X

FRACTURE SURFACES

Longitudinal Samples

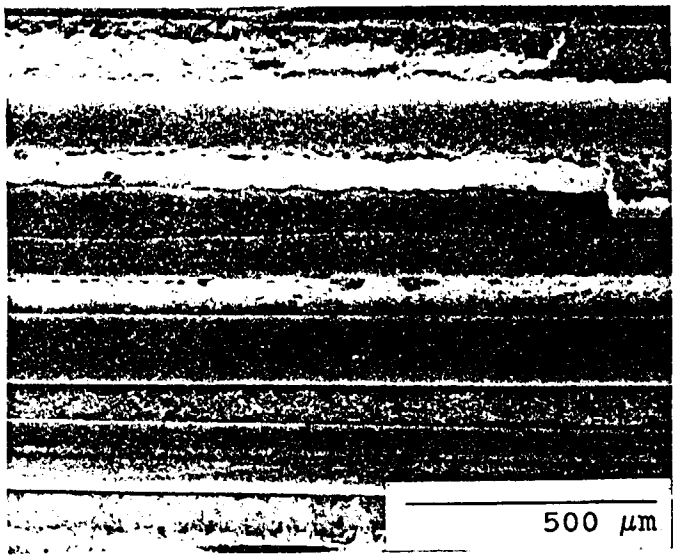


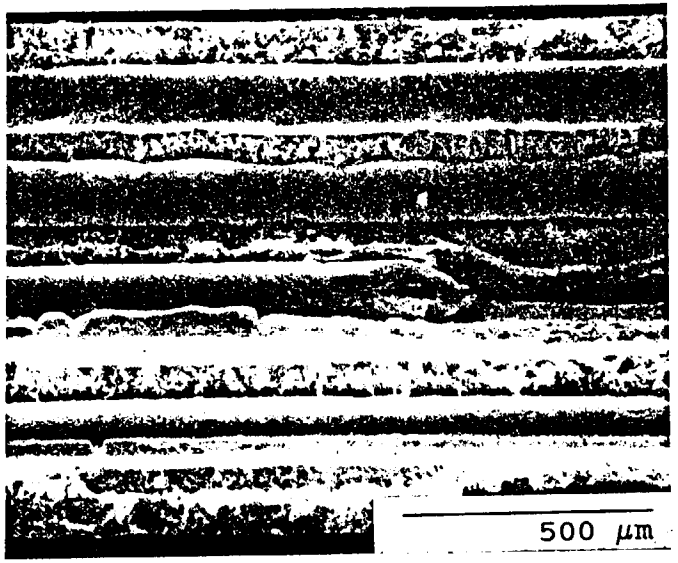
As-Fabricated

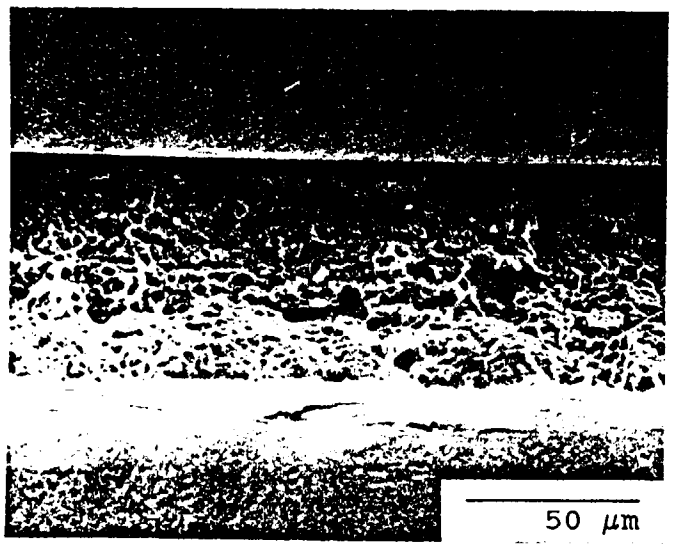
Air 150-800C 500X

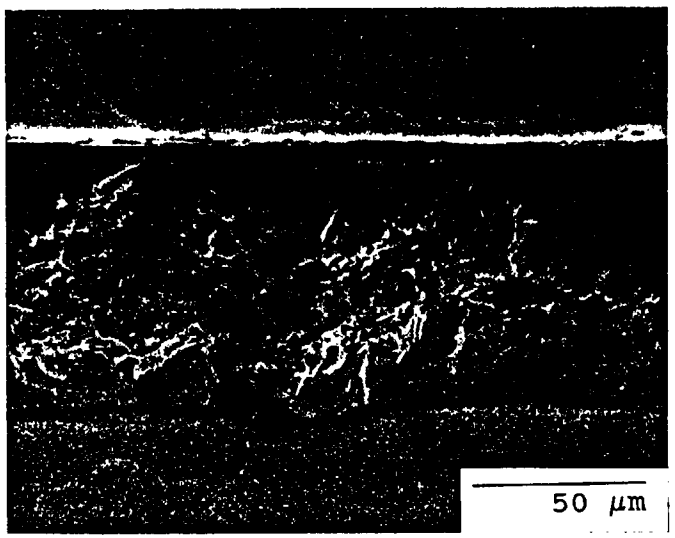
FRACTURE SURFACES

Transverse Samples









As-Fabricated **Air 150-800C 500X**

SUMMARY

- After fabrication the Sigma fiber reacted at nearly the same rate as SCS-6
- Thermal cycling in argon had no significant effect on the composite tensile properties
- Thermal cycling in air up to 700C shows little decrease in tensile strength, but cycling to 800C had an appreciable effect
- Fracture surface characterization indicates that oxidation of the matrix leads to a localized brittle failure mode

FUTURE WORK

- Investigate matrix microstructural changes
- Compare thermal cycling to equivalent isothermal exposure
- Compare to composite of BETA 21S
- Cryogenic thermal cycling